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Fossil woods resembling *Saraca indica* L. and *Ougenia dalbergioides* Benth. from the Mio-Pliocene of West Bengal, India

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Abstract

Two permineralized fossil woods viz., *Saracoxylon indicum* gen. et sp. nov. and *Ougenioxylon bengalensis* sp. nov. are discribed for the first time from Mio-Pliocene formations of Burdwan and Birbhum Districts of West Bengal, India. The fossil wood resembling *Ougenia* was previously reported from the Tertiary of Assam; the occurrence of fossil wood resembling *Saraca indica* from the Indian Tertiary is a new record.

INTRODUCTION

The fossil woods of dicots are the frequently occurring megafossil in the Tertiary sedimentary deposits of Peninsular India. So far 23 genera of fossil woods referable to Fabaceae have been instituted. These are : *Adenantheroxylon* Prakash & Tripathi (1968), *Aeschynomenoxylon* Muller-Stoll & Madel (1967), *Albizinium* Prakash (1975), *Baphioxylon* Trivedi & Srivastava (1986), *Bauhinium* Trivedi & Panjwani (1986), *Caesalpinioxylon* Schenk (1890), *Cassinium* Prakash (1978), *Cynometroxylon* Chowdhury & Ghosh (1946), *Dalbergioxylon* Ramanujam (1960), *Dialiumoxylon* (Lemoigne) Trivedi & Misra (1978), *Erythrophloexylon* Muller-Stoll & Madel (1967), *Enacicioxylon* Muller–Stoll & Madel (1967), *Hopeoxylon* (Navale) Awasthi (1977), *Isoberlinioxylon* (Lakhanpal & Prakash) Guleria (1984), *Koompassioxylon* (Kramer) Bande & Prakash (1980), *Millettioxylon* Awasthi (1975), *Ormosioxylon* Bande & Prakash (1980), *Ougenioxylon* Prakash & Tripathi (1977), *Pahudioxylon* Chowdhury, Ghosh & Kazmi (1960), *Peltophoroxylon* (Muller-Stoll & Madel) Bande& Prakash (1980), *Pericopsoxylon* Awasthi (1979), *Pterogynoxylon* Muller-Stoll & Madel (1967) and *Tamarindoxylon* Ramanujam (1961). These woods have been described from a number of different formations spread over North-Eastern India, West Bengal, Bihar, Kalagarh in U. P., Pondicherry, Kutch and Deccan Intertrappeans. It appears that Fabaceae formed a dominant feature in the Mio-Pliocene vegetation of Indian Peninsula.

Saracoxylon indicum gen. et sp. nov. and *Ougenioxylon bengalensis* sp. nov. from the Mio-Pliocene sedimentary deposits of Burdwan and Birbhum Districts of West Bengal are reported here for the first time.

Family : Leguminosae
Subfamily : Caesalpinioideae

Saracoxylon Roy et Mukhopadhyay, gen. nov.

Diagnosis

Wood diffuse porous; Growth rings demarcated by terminal parenchyma; pores moderately large to small, distributed in oblique lines; tyloses absent, intervessel pits vestured, minute; vessel members short and with tail endings; perforations are simple; parenchyma are apotracheal terminal and paratracheal aliform to confluent bands of 2–3 series, nonstoried. Rays are 1–2– seriate mostly uniseriate, short or medium in length, heterocellular, nonstoried; fibres libriform, nonseptate and nonstoried, ripple marks not present.

Saracoxylon indicum Roy et Mukhopadhay, sp. nov. (Fig. 1, A – G)

The fossil wood described here is a piece of petrified material of reddish brown colour and angular shape. It measures 8 cm in length and 5 cm in diameter.

Diagnosis

Wood diffuse porous; growth ring delimited by terminal parenchyma; vessels 52 μm – 130 μm (t. d.) and 65 μm – 190 μm (r. d.), round to oval, solitary or in radial multiples of 2–3 or in irregular clusters, tyloses absent; intervessel pits round, 3 μm – 4μm in diameter, indistinctly vestured; vessel members with tailed ends; vessels 3–4/ mm^2 distributed in oblique lines; parenchyma terminal and aliform to confluent, nonstoried; xylem rays mostly uniseriate, occasionally biseriate, 5–20 cells high, heterocellular with one or two marginal upright cells; fibres libriform, nonseptate, non-storied, ripple marks absent.

Holotype	:	A30, Palaeobotanical Collection of Botany Department, Burdwan University, West Bengal, India.
Locality	:	Aduria Forest, Burdwan District, West Bengal, India.
Horizon	:	Tipam Series
Age	:	Miocene

Explanation of Fig. 1. A. *Saracoxylon indicum* gen. et sp. nov. : t. s. showing the distribution of vessels, xylem parenchyma and rays (x 50); B. *Saraca indica* L. : t. s. showing similarities with fossil wood (x 30); C. t. l. s. showing predominantly uniseriate, heterocellular rays and libriform non-septate fibres (x 80); D. *Saracoxylon indicum* : t. l. s- note the similarities with the extant member (x 80); E. r. l. s. showing the nature of intervessel pits (x 700); F. *Saraca indica* L .: r. l. s. – note the procumbent cells and upright cells on both ends of ray (x 700); G. r. l. s. – note the identical intervessel pits with the fossil (x 700); H. *Ougenioxylon bengalensis* sp. nov. : t. s. showing the distribution of vessels in oblique, diagonal pattern, aliform-confluent xylem parenchyma (x 50); I. t. l. s. – note the occurrence of 2–3– seriate rays predominantly homocellular and storied parenchyma and rays (x 80); J. r. l. s. showing vestured intervessel pits (x 700).

Fossil woods resembling *Saraca indica* L. and *Ougenia dalbergioides* Benth.

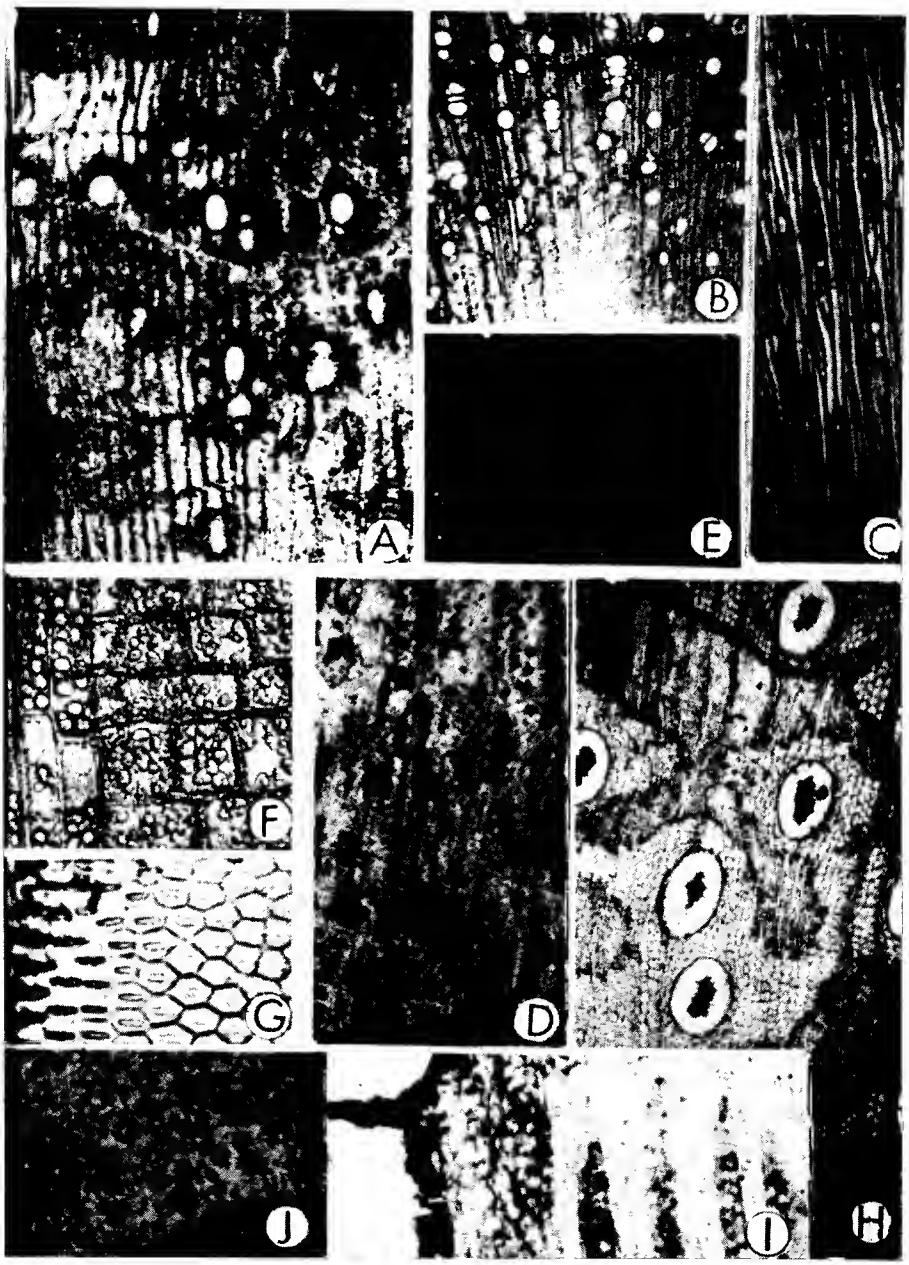

Figure 1.

Description

Wood is diffuse porous; growth ring is distinctly delimited by the continuous line of terminal apotracheal parenchyma; vessels are typically arranged in oblique lines, solitary and in radial multiples of 2-3, occassionally in irregular clusters. Pores are round to oval in shape, medium to moderately large in size, t. d. 52 μm – 130 μm and r. d. 6 5μm – 190 μm; walls of the vessel are distinct; 3- 5 pores occur per mm^2. Tyloses are absent. Vessel members are typically short with tailed end, 195 μm – 390 μm long, perforation is simple, intervessel pits are alternately arranged, round or polygonal, adpressed to each other and hexagonal in shape, minute, 3 μm–4 μm in diameter and vestured. Axial parenchyma are apotracheal and paratracheal. Apotracheal parenchyma occur as continuous, 1–2– seriate thin line limiting the growth rings. The paratracheal parenchyma occur as aliform or confluent bands of 2–3 series of cells. These extensions rarely join adjacent or even distally located vessels, or the bands end blindly. Parenchyma is nonstoried.

Rays are closely spaced, occurring 10–14/mm; are 1–2– seriate, mostly uniseriate, some are partly or totally biseriate; are short, 3–20 cells, 130 μm – 520 μm in height, heterocellular with 1–2 upright cell(s) at one or both end(s), rest of the part is constituted by procumbent cells. The procumbent cells are 13 μm – 20 μm in r. d. and 39 μm – 45 μm in t. d. whereas the upright cells are 13 μm – 30 μm in t. d. and 45 μm – 52 μm in r. d. Rays are nonstoried. Fibres are libriform; 10 μm – 16 μm broad, nonseptate, non-storied and pits are not found.

Affinities and Comparisons

The characters of the wood are individually present in many of the angiospermic families, but in a combination these are distributed among a very few families viz., Combretaceae, Meliaceae, Rutaceae and Leguminosae (Metcalfe and Chalk, 1950).

Some species of *Terminalia* e. g., *T. catappa*, *T. myriocarpa*, and *T. oleracea* of Combretaceae show striking similarities with the present fossil wood in respect to shape and distribution of vessels, aliform-confluent and terminal parenchyma, vestured pits, uniseriate and partly biseriate rays (Rao & Purkayastha, 1972). But in *Terminalia* the vessels are markedly larger in size, intervessel pits are distinctly large and rays are homocellular containing crystals unlike the fossil wood.

In the family Meliaceae, *Aglaia edulis* shows some resemblances to the fossil wood in the nature of parenchyma, rays and fibres. But *Aglaia* can be distinguished by the presence of septate fibres which are absent in the concerned fossil wood.

Inspite of some superficial similarities with the fossil wood e. g., in the presence of aliform – confluent and terminal parenchyma, fine rays and libriform fibres, the woods of *Citrus* spp. can easily be distinguished by their possession of extremely minute vessels, homogeneous rays and concentric rows of vertical gum canals.

The combinations of characters exhibited by the fossil wood occur in Caesalpinioideae viz., oblique arrangement of the vessels, terminal bands of apotracheal parenchyma and fine (1–3– seriate), heterocellular, nonstoried rays (Metcalfe & Chalk, 1950; Reinders – Gouwentak & Rijasdijk, 1955).

Among the members of Caesalpinioideae, the woods of *Poinciana regia, P. elata, Saraca indica, Tamarindus indica* show gross similarities with the fossil wood. The presence of terminal parenchyma, predominantly aliform parenchyma with thin lateral extensions, solitary and radial multiples of vessels, fine xylem rays, libriform and nonseptate fibres are the common features between the fossil and the extant taxa mentioned above.

In *Poinciana elata* and *P. regia* the rays are 1–4– seriate and homogeneous unlike the 1–2– seriate, heterogeneous rays of the fossil wood. *Tamarindus indica* differs from the fossil wood in possessing 1–3– seriate homogeneous rays.

The wood of *Saraca indica* resembles with the fossil wood in all the major diagnostic features, viz., the vessels are medium sized, non-tylosed and distributed in oblique lines; parenchyma are terminal and aliform to confluent, nonstoried. Rays are 1–2– seriate (mostly uniseriate), heterocellular, nonstoried and fibres are libriform, nonseptate and nonstoried.

A detailed comparison of the present fossil wood with the wood of *Saraca indica* in three plains T. S., T. L. S. and R. L. S. has been done by the author. Both are identical except that, in the modern wood of *Saraca indica* some rays, specially the shorter ones are exclusively made of upright cells. But it is not a constant feature throughout the different levels of growth. Hence this feature is not considered to be an important one. So, the fossil wood is described as *Saracoxylon indicum* gen. et sp. nov.

Present distribution of *Saraca indica* Linn.

There are five Indian species of *Saraca.* The concerned species viz., *S. indica* occurs in Bengal, Orissa, Konkan, Kanara and Khasi Hills (Gamble, 1902; Brandis, 1906). Outside India it has been reported from Sri Lanka, Java and Burma (Gamble, op. cit.; Brandis, op. cit.).

Family : Leguminosae
Sub-family : Papilionoideae

Ougenioxylon bengalensis Roy et Mukhopadhay, sp. nov. (Fig. 1, H–J)

The fossil wood is represented by 3 pieces of petrified materials. All measure about 8 cm in length and 5 cm in breadth. The shape is irregularly quadrangular and colour is greyish yellow due to the deposition of laterites and felspartic grits.

Diagnosis

Wood is diffuse porous; growth ring is delimited by thin inconspicuous terminal parenchyma line. Vessels are 70 μm – 260 μm in t. d. and 90 μm – 300 μm in r. d. Pores are obliquely distributed in diagonal order, and 50% are solitary and 50% as radial multiples of 2–6; tyloses are absent bu brownish gummy deposits partially plug the pores; 8–12 pores/ mm^2. The vessel members are 450 μm – 700 μm long, storied, with either straight or tailed ends; intervascular pits are round, 4 μm – 7 μm in diameter, opposite to subopposite arranged. Parenchyma apotracheal terminal predominently paratracheal as aliform and aliform-confluent, storied. Xylem rays 2–4- seriate, heterocellular with a terminal upright cell at both the ends, storied, 6–18 cells high, uniseriate being rare. Fibres are semilibriform, 140 μm – 300 μm long and 18 μm – 25 μm in width, septate and nonseptate types. Ripple marks are very distinct due to regularly storied vessel elements, parenchyma and xylem rays.

Holotype & Syntypes : UR26, UR49, UR95, Palaeobotanial Collection of Botany Department of Burdwan University, West Bengal, India.

Locality : Uttar Raipur, near Suri, Birbhum District, West Bengal, India

Horizon : ? Tipam formation

Age : Miocene – Pliocene

Description

Wood is diffuse porous; growth rings are present but inconspicuously delimited by thin line of terminal parenchyma. Pores are solitary as well as radial multiples of 2–6, not tylosed but partly filled with gummy deposits. In cross section the solitary pores appear as round to oval in shape, and the pores within the multiples are either horizontally flattened or variously deformed due to compression. The vessels are 70 μm – 260 μm in t. d. and 90 μm – 300μm in r. d.; walls are moderately thick, number of vessels per mm^2 ranges from 8–12. The pores are distributed in an oblique or diagonal pattern as seen in cross section. The vessel elements are 450 μm – 700 μm long, storied; and are with straight and tailed ends; perforation is simple; intervessel pits are round, 4 μm – 7 μm in diameter, with irregularly round apertures, vestured, opposite to subopposite in arrangement. Axial parenchyma are paratracheal and apotracheal; when paratracheal, they are predominantly aliform to confluent joining 2–3 vessels or vessel multiples within short distance. Parenchyma are storied; apotracheal parenchyma are forming very thin indistinct terminal lines. The xylem rays are 1–4– seriate (mostly 2–3– seriate), uniseriate is rare, either homocellular consisting of procumbent cells only or heterocellular ones with one upright terminal cell each at both the ends. Rays are distinctly storied, 6–8 cells high and spindle-shaped. The procumbent cells are 18 μm – 24 μm in radial length and 12 μm – 26 μm in height, the upright cells are 15 μm – 25 μm in radial length and 25 μm – 85

µm in height; 7–10 rays occur/mm. Fibres are semilibriform, 18 µm – 25 µm in width and 140 µm – 300 µm in length, septate and nonseptate types are present; ripple marks are very prominent due to regularly storied parenchyma, vessel segments and xylem rays.

Affinities and Comparisons

Precisely, the fossil wood belonging to the subfamily Papilionoideae is having the following wood anatomical features (Metcalfe & Chalk, 1950) : 1) vessels are distributed in oblique pattern, 2) very thin terminal parenchyma line of 1–2 cells thickness, 3) paratracheal parenchyma with gable-ends, which are storied, 4) distinctly storied, 1–4– seriate (mostly 2–3– seriate) xylem rays which are commonly heterocellular, 5) prominent ripple marks caused by storied vessel elements, parenchyma and rays, 6) though rare but septate fibres also occur in some taxa.

The taxa which are comparable to the present fossil wood are *Dalbergia assamica, D. latifolia, D. sissoides* and *D. sissoo,* in possessing storied parenchyma, homocellular to heterocellular, storied and 1–3– seriate rays. But all of them markedly differ from the wood described here in having narrow, aliform confluent parenchyma unlike the typical 'eyelets' found in the present fossil. Also the septate fibres are absent in *Dalbergia* unlike the fossil wood.

Pericopsis mooniana is similar to the fossil to some extent e. g., in vessel size, shape and distribution, type of parenchyma, presence of ripple marks caused by the storied elements. But the absence of terminal parenchyma, 1–4– seriate, heterocellular rays and septate fibres make it separate from the fossil wood described here.

The species of *Ormosia* differ from the present fossil wood in lacking terminal parenchyma, septate fibres and storied rays. Otherwise they show apparent similarities by their possession of homocellular to heterocellular, 1–4– seriate, short rays, typical aliform to broad and locally aliform–confluent parenchyma which may be storied. The wood anatomy of *Ougenia dalbergioides* Benth. resembles the fossil wood by the presence of the following : 1) terminal parenchyma, 2) solitary and radial multiples of vessels, 3) aliform and aliform-confluent parenchyma, 4) 1–4– seriate, storied rays which are homocellular to heterocellular (Kribs II Type), 5) fibres either septate or nonseptate.

A comparison of the present specimen with fossil wood genera of Papilionoideae so far described indicates its nearest approach to *Ougenioxylon tertiarum* Prakash & Tripathi. All the major characters of both the specimens are almost similar at the generic level. However, some differences in a few quantitative characters viz., vessel elements and rays are noted between the two. The present specimen can also be distinguished from *O. tertiarum* by having heterocellular rays with a single marginal upright cell and in lacking apotracheal diffuse parenchyma.

Though in the generic diagnosis of *Ougenioxylon* Prakash and Tripathi (1975) have mentioned that the xylem rays are homocellular consisting of procumbent cells, Metcalfe and Chalk (1950) have not included *Ougenia* under those papilionaceous genera which have exclusively homocellular rays of Kribs I, II and III types (Kribs, 1935, 1959).

Present distribution of *Ougenia dalbergioides* Benth.

Ougenia is a monotypic genus indigenous to India (Willis, 1966). *O. dalbergioides* is a small tree occurring in Northern and Central India, Lower Himalayan tract from the Jhellum to Bhutan (ascending upto 5000 ft. and very common in hot valleys and forest of *Pinus longifolia),* Nepal, Punjab, North-Eastern Province, Oudh, Chhotanagpur, Bombay, Nilgiris, Siwaliks (Gamble, 1902; Brandis, 1906; Rao & Purkayastha, 1972). It is not common in Bihar and Orissa except Sambalpur, and in South India except Coimbatore, Madura, Coorg, Hyderabad and Mysore (Pearson & Brown, 1932).

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